International Journal of Medicine
and Pharmaceutical Science (IJMPS)
ISSN (P): 2250-0049; ISSN (E): 2321-0095
Vol. 11, Issue 2, Dec 2021, 9–18

TRANS STELLAR
•Journal Publications •Research Consultancy

A REVIEW ON ANTIDIABETIC AND ANTIMICROBIAL ACTIVITY OF MEDICINAL GRASSES OF POACEAE FAMILY

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ABSTRACT

Diabetes and microbial infection are widespread in most countries around the world, the epidemic is rapidly spreading. It has been reported that some medicinal grasses of Poaceae family such as Cynodon dactylon, Cymbopogan citratus, Triticum aestivum* and *Bambusa vulgaris contains pharmacologically active phyto-constituents. Medicinal grasses are rich in variety of phyto-constituents such as tannins carotenoids, alkaloids, glycosides, flavonoids, saponins, triterpenoides and other numerous compounds. Diabetes mellitus is an endocrine system metabolic disorder. Diabetes is another name for diabetes mellitus. Mainly two types of diabetes first one are Type 1 diabetes and the second one is Type 2 diabetes. Type 1 diabetes is insulin-dependent, whereas Type 2 diabetes is not insulin-dependent. The medicinal grasses of poaceae family have a potential antidiabetic and antimicrobial activity. The antidiabetic potential of medicinal grasses maintained by hypoglycemic, antihyperglycaemic and hypolipidemic effects of different phyto-constituents present in different parts of medicinal grasses. Antimicrobial activity is also exhibited by the presence of variety of phyto-constituents against different group of microorganism such as grampositive bacteria, gramnegative bacteria, fungi. The distinct concentration and doses show variable medicinal effects. The current review focuses on antidiabetic and antimicrobial activity of medicinal grasses of poaceae family.

KEYWORDS: Antidiabetic, Antimicrobial, Diabetes Mellitus, Phyto-Constituents & Hypoglycemic

Received: May 04, 2021; **Accepted**: May 24, 2021; **Published**: Jun 12, 2021; **Paper Id.**: IJMPSDEC20212

Original Article

Introduction

In many developed countries, the 3rd leading cause of death (after cancer and heart disease) is diabetes mellitus. It is a group of metabolic variations marked by hyperglycemia caused by defects in insulin secretion, action or both. Diabetes affects the nervous system, kidney and eyes [1]. Generally, Diabetes mellitus are four main types- (i) Type 1 diabetes is an autoimmune disease. It is usually found in children and adult but it can develop at any age. Up to 10% of people have type 1 diabetes. Type 1diabetes is also known as insulin-dependent diabetes because people need to take insulin every day. (ii) Type 2 diabetes is the most common diabetes. Up to 95% of people have diabetes type 2. In type 2 diabetes, your body cells are not able to react normally to insulin. (iii) Prediabetes (iv) Gestational diabetes-: During pregnancy develop this type of diabetes mellitus in women [2].

Medicinal plants contain a wide range of potential drugs, and they are the most sustainable, environmental friendly and safest alternative to synthetic drugs. Medicinal plants are also high in phyto-constituents and play an important role in drug development. Medicinal plant extracts are effective to treat a variety of health issues [3]. Microbial infections, cancer, diabetes, cardiovascular disease and inflammation are just a few examples. Some medicinal grasses of the Poaceae family with anti-diabetic and anti-microbial activities are *Cynodon dactylon, Cymbopogan citrates, Triticum aestivum, Bambusa vulgaris*.

Cynodon dactylon is commonly known as dhoob grass and bermuda grass. It contains many phyto-constituents, phyto-constituents are flavonoids, carotenoids, phenolics, phytosterols, glycosides, saponins and volatile oils [3]. Different parts of *Cynodon dactylon* such as root, stem, leaf exhibits antidiabetic and antimicrobial activity with variant efficacy [4]. It's a prostrate, warm season, perennial grass that spreads through scaly rhizomes and flat stolons to form a dense, resilient turf. The conspicuous ring of white hairs on the ligule, the fringe of hairs on the keel of the lemma and the gray-green appearance of the foliage are all distinguishing features of *Cynodon dactylon*. It grows only in disturbed areas and requires high temperatures and high light levels to bloom. Despite being drought tolerant, it prefers to grow where water is available.

Cymbopogan citratus commonly known as citronella grass and lemon grass. The important constituents such as anthocyanin, phytosterols, phenolic compounds, flavonoids, furfurol, p-coumaricacid, L-linanool have been extracted and characterized from *C. citratus* [5]. They have many therapeutic activities like antimicrobial, anti-inflammatory, anti- diabetic, anti-cancer amongst others are well reported [6]. Lemon grass is a tufted perennial grass that grows from short rhizomatous roots and produces numerous stiff leafy stems. The leaf blade is linear with tapered ends. The pseudostem is formed by the leaf-sheath, which is tubular in shape. Long, glaucous, green leaves with a linear shape that taper upwards and along the margins. When this plant reaches a mature stage of development, it produces flowers. Flowering, on the other hand, has never been seen under cultivation due to the quick harvesting time.

Triticum aestivum is commonly known as wheat grass. The presence of phyto-constituents such as phenolic, flavonoid, alkaloid and others contributes to the effectiveness of the wheat extracts. It is the largest edible grain cereal grass crop on the planet. Wheat plant is a grass that grows annually [7]. Wheat grass grows on a vast area of land under diverse conditions. It is drought tolerant because of several genes and produces various kinds of proteins and enzymes, such as responsive to abscisic acid (Rab), late embryogenesis abundant (lea), helicase, rubisco, glutathione-S-transferase (GST), proline, and carbohydrates throughout drought stress [8]. Among all cereal crops, wheat is a rich source of protein. Wheat grass also has the ability to regulate blood sugar level. It uses as an anti-diabetic agent is becoming more popular these days.

Bambusa vulgaris is commonly known as golden bamboo. Although it is classified as grass, but it has a tree-like habit. It has a wide range of medicinal properties, and well is rich in nutritious composition and immense in proteins, vitamins, phenolic compounds, beta-carotene and amino acids [9]. The leaves of *Bambusa vulgaris* contain phytosterols and tannins which exhibit antidiabetic effect in streptozotocin induced diabetic rats [10]. The culms of *Bambusa vulgaris* are glossy, bright green, yellowish on maturity and narrow leaves. The nodes are noticeable, with the lower ones having a narrow ring of roots and being covered in brown hairs. A few to many clustered branches with one to three larger dominant branches. Branches commonly appear from the middle of the culm to the top. It thrives vigorously on moist soil and in humid conditions in cultivation, but it can tolerate a broad range of climatic conditions and soil types. The bamboo plants may become completely defoliated during the dry season, but they will recover once the rainy season begins. This bamboo species can withstand as low as -3°C temperature and is well adapted to semi-arid environments, as well as on degraded and flooded lands.

Phyto-Constituents and Therapeutic Value of Medicinal Grasses of Poaceae Family

Phyto-constituents are those compounds that are produced by plants consists macronutrients and micronutrients. The presence of phyto-constituents and secondary metabolites in medicinal plants contributes to their therapeutic potential. In medicinal plants, these compounds are uniformly dispersed. Through primary or secondary metabolism, they can be found in all part of plants. They generally play a role in the growth of plant and have biological activity in plant protection.

Many compounds of different morphological components of *Cynodon dactylon* have been identified and classified. Plant contains mineral, carbohydrates, proteins and other compounds such as trepenoids, vitamin C, palmitic acid and alkaloids. The other reported important phyto-constituents of this plant are flavonoids and carotenoids. The aqueous and alcoholic extract of parts of plant which are completely exposed to the air, they includes-stem, node, internode, axillary bud, petiole, leaf and apical bud of *C. dactylon* exhibited antidiabetic and wound healing [11].

A variety of compounds have been isolated from *Cymbopogan citratus* such as – anthocyanins, phytosterols, organic acids, amino acids, volatile compounds, phenolic compounds, fumesol, fatty acids, flevonoids, methylheptenone, L-linanool, isovaleranic aldehyde, valeric esters, isopulegol, furfurol, and p-coumaric acid.. Essential oil and flavonoids are the most important components in *C. citratus* and they contribute to the plant's apparent healing and medicinal activity. Essential oils such as alpha-citral and beeta-citral have been isolated and analysed from the leaves of *C. citratus*. These compounds had antimicrobial activity against gram-negative and gram-positive bacteria and also antidiabetic activity of *C. citratus* have been investigated against type 2 diabetes via alpha-glucosidase and alpha-amylase inhibitory assay [12].

Triticum aestivum contains several phyto-constituents like Vitamins- vitamin A, B1 B2, B3, B5, B6, B8, B12, C, E, K and minerals- ascorbic acid. Enzymes like cytochrome oxidase, protease, transhydrogenase amylase, superoxide dismutase (SOD), lypase and other exclusive phyto-constituents such as amino acids- threonine, aspartic acid, glutamine, asparagines, glycine, proline, alanine, arginine, methionine, valine, isoleucine, phenylalanine, tyrosine, lysine, tryptophan, histidine, serine and bioflavonides like apigenin, quercitin, luteonin. Wheat grass components are very effective and beneficial in serious disease such as heart disease, digestive system, diabetes, leucoderma, leukaemia and cancer disease. *Triticum aestivum* powder shows good improvement in relieving digestive system problems and diabetes. Due to the presence of chlorophyll, the pharmacologically active ingredient in wheatgrass is believed to act as an antidiabetic agent [13].

The phyto-constituents of *Bambusa vulgaris* are glycosides, saponins, carbohydrates, phenolics, tannins, alkaloids, flavonoids, phytosterols, and triterpenoids, oils, and fats [14]. Alkaloids, terpenoids, flavonoids, and tannins have exhibit potential in the development of modern antimicrobial chemotherapies. Diverse analysis estimate these phyo-constituents and have been investigated by many researchers to be bioactive and have therapeutic as well as physiological properties. Human diseases such as viral, fungal and bacterial treated by the use of many group of flavonoids. Enhancement in oxidation resistance has been demonstrated by many phenolic terpenoids and carotenoids. It is also used in traditional medicine to treat many infectious diseases like measles, respiratory diseases, diarrhea, sexually transmitted diseases (e.g., gonorrhea), inflammations, wounds and ulcers. Furthermore, a preliminary phytochemical profile revealed that the phyto-constituents composition varies with *B. vulgaris* plant extract [15]. In streptozotocin-induced diabetic rats, *Bambusa vulgaris* leaf extracts have been found to have anti-diabetic activity and were effective in lowering blood sugar level significantly [14].

Antidiabetic Activity of Different Parts of Medicinal Grasses

The target in treating diabetes is to prevent high blood glucose level throughout each successive period of 24 hours without producing hypoglycemia. Antidiabetic potential of plants demonstrated by hypoglycemic, antihyperglycaemic and hypolipidemic activity of phyto-constituents. Hypoglycemic and antihyperglycaemic compounds reduces the glucose level in blood. The level of lipids and lipoproteins (lipid-protein complexes) in the blood is reduced by hypolipidemic compounds. High levels of certain lipoproteins are low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL), have been associated with an increased risk of cardiovascular disease, such as heart attack, coronary artery disease, and stroke. There are several methods used to evaluate the antidiabetic effects of medicinal grasses at different doses. The dose

study normally estimate the oral glucose tolerance test, blood sugar, fasting blood glucose. The most commonly used diabetic models were streptozotocin and alloxan-induced diabetic mice or rats. Streptozotocin (STZ), a glucosamine–nitrosourea compound derived from *Streptomyces achromogenes*, induced diabetes. It's a broad-spectrum antibiotic with diabetogenic, antitumor, oncogenic properties and clinically is used as a chemotherapeutic agent in the treatment of pancreatic β-cell carcinoma. STZ causes hypoinsulinemia and hyperglycemia by damaging pancreatic β-cells. [16]. Alloxan a beta cytotoxin, induces diabetes by causing a massive reduction of the insulin secreting β-cells of the islets of langerhans by free radical generation. It is resulting in a decrease in endogenous insulin release, which paves the way for decreased glucose utilization by the tissue [17]. There are some medicinal grasses that shows antidiabetic activity are listed in table 1.

Table 1: Some Medicinal Grasses that show Antidiabetic Activity

	Medicinal grass	Family/ Common name	Part	Phyto-constituents	Experimental model	Antidiabetic activity	References
1.	*Cynodon dactylon*	Poaceae/ dhoob grass and bermuda grass	Whole plant	-	Male albino wistar rats- normal and streptozotocin induced diabetic rats	Antidiabetic potential- hypoglycemic and hypolipidemic effects. Dose- 500 mg/kg Normal rats- lowers blood glucose level around 31% after 4 h of administration. Mild diabetic rats- a fall of 23% in blood glucose level within 1 h during glucose tolerance test (GTT). Severely diabetic rats- were also treated daily with 500 mg/kg bw for 14 days and a significant reduction of 59% was observed in fasting blood glucose level. Total cholesterol (TC), low density lipoprotein (LDL) and triglyceride (TG) levels were decreased by 35, 77 and 29%, respectively, in severely diabetic rats.	[18]
			Whole plant	Fats, flavonoids, steroids, carbohydrates, alkaloids, saponins	Wistar rat Glucose overloaded hyperglycemic rat and alloxan induced diabetic model	Glucose overloaded hyperglycemic rat- antihyperglycaemic effect/ dose 400 mg/kg Fasted normal rat- non polysaccharide fraction exhibited hypoglycaemic activity/ dose 200 mg/kg and 400 mg/kg Alloxan induced diabetic rat- after 7 days treatment of diabetic animals with plant extract, its fraction (AqNPF)/ dose 200 mg/kg and 400 mg/kg and glibenclamide/ dose 5	[19]

						mg/kg, values of blood glucose decreased significantly	
2.	*Cymbopo -gan citrates*	Poaceae/ citronella grass and lemon grass	Fresh leaf	-	Male wistar rats	Period- 42 days Hypoglycemic effect seen at the oral dose of 500 mg/kg/day of the extract and hypolipidemic effects- lowered the plasma total cholesterol , low-density lipoproteins (LDL-c), very low-density lipoprotein (VLDL-c)/ dose 500 mg/kg.	[20]
			Whole plant	-	Male albino rats (Wistar strain)	Hypoglycemic activity Dose 200 mg/kg Period- 30 days Reduction in blood glucose level	[21]
3.	*Triticum aestivum*	Poaceae/ wheat grass	Grass	Alkaloids, Flavonoids, Glycosides, Saponins, Tannins, Phytosterols, Triterpenoid, Amino acids, Protein	Male albino Wistar rats streptozotocin -induced diabetic rats	Antihyperglycemic, hypolipidemic Dose- 100 mg/kg Period- 30 days Increased- liver glycogen Decreased- fasting blood glucose, glycosylated hemoglobin levels, and serum marker enzyme levels. Reduced- total cholesterol and serum triglycerides levels, low density lipoprotein, and very low density lipoprotein Increased - high density lipoprotein level	[22]
			Wheat seed	-	Alloxan-induced diabetic rats	Normoglycemic Period- 28 days Diabetic rats fed on Triticum aestivum seed decrease in fasting blood glucose level, bilirubin, urea, creatinine and increase in albumin, globulin, Na^+, and K^+, insulin and glycogen concentrations, activities of hexokinase, catalase, superoxide dismutase, and glutathione peroxidase, ameliorates the activities of carbohydrate metabolism enzymes reduced activities of glucose-6-phosphatase and fructose 1,6-diphosphatase and concentration of MDA and reversed activities of AST and GGT; ALP	[23]

						and regeneration of liver, kidney, and pancreas tissues	
4.	*Bambusa vulgaris*	Poacea -e/ golden bambo -o	Leaves	Phytosterols and tannins	Streptozotocin induced diabetic rats - Swiss albino mice of female sex and male albino rats of Wistar strain	Dose- 200 mg/kg and 400 mg/kg Period- 15 days Petroleum ether extract of Bambusa vulgaris leaves lowered the fasting blood sugar level of hyperglycemic rats	[24]
			Aerial part	Alkaloids and saponins	Swiss albino mice	Antihyperglycemic activity, lowers blood glucose levels 32.8% by 100 mg/kg dose, 45.8% by 200 mg/kg, 55.3% by 400 mg/kg	[25]

Antimicrobial Activity Of Medicinal Grasses Against Different Microbial Isolates

The presence of phyto-constituents in plants resembles the antimicrobial activity. Different parts and different concentration of phyto-constituents of individual plant varies the antimicrobial effect. The most common assay to determine and calculate the antimicrobial effect is disc diffusion assay. In this assay zone of inhibition and minimum inhibitory concentration value is analyzed. Antimicrobial effect of some medicinal grasses of poaceae family with their phyto-constituents, inhibition zone diameter and minimum inhibitory concentration (MIC) value against different microorganisms are listed in Table 2.

Table 2: Some Medicinal Grasses of Poaceae Family that shows Antimicrobial Activity

	Medicinal Grass	Part	Phyto-Constituents	Microorganisms	References
1.	*Cynodon dactylon*	Aerial Parts	Alkaloids, Anthroquinone, Flavonoids, Saponins, Steriods, Tannins, Triterpenoids	Zone of inhibition with 75 µl solvent leaf extracts Gram negative bacteria - *Escherichia coli*- 3.8 mm and *Klebsiella pneumonia* - 4 mm; Gram positive bacteria - *Bacillus subtilis*- 3.8 mm, *Pseudomonas aeruginosa*- 3.6 mm and *Staphylococcus aureus*- 4 mm	[26]
		Whole part	-	Size of inhibition zone (mm) Ethanol and ethyl acetate extracts *Bacillus cereus* Ethanol- 9.0 ± 0.0, Ethyl acetate- 12.0 ± 1.0; *Bacillus subtilis* Ethanol- 7.0 ± 0.0, Ethyl acetate- 8.0 ± 0.0; *E. coli* Ethanol- 8.3 ± 0.6, Ethyl acetate- 8.0 ± 0.0; *Klebsiella spp.* Ethanol- 8.3 ± 0.6, Ethyl acetate- 8.0 ± 0.0; *P. aeruginosa* Ethanol- 8.0 ± 0.0, Ethyl acetate- 9.3 ± 0.6; *S. aureus* Ethanol- 9.0 ± 1.0, Ethyl acetate- 10.0 ± 0.0; *Streptococcus pyogenes* Ethanol- 10.0 ± 1.0, Ethyl acetate-8.0 ± 0.0; *Streptococcus pneumonia* Ethanol- 7.3 ± 0.6, Ethyl acetate- 7.0 ± 0.0	[27]

2.	*Cymbopogan citratus*	Leaves	Essential oil n-Hexadecanoic acid, Palmitic acid, Pentadecanec arboxylic acid, 2-Methyl-Z, 13-octadecadienol	*Streptococcu ssp.*- 22mm (Diameter of inhibition zone)	[28]
		Leaves	Total Phenolic Compounds TPCs- 130.33 mg GAE/100 g dry weight of plant material Total Flavonoids TFs- 193.63 mg quercetin/100 g dry weight	Zone of inhibition (mm) 100 mg/ml lemongrass MeOH concentration *Bacillus subtilis*- 15 mm, *Staphylococcus aureus*- 10 mm and *Listeria spp*.- 14 mm	[29]
3	*Triticum aestivum*	Leaf, stem, root, awn, seed and the whole plant	-	Gram- negative bacteria : *Escherichia coli* and gram- positive bacteria : *Bacillus subtilis, Staphylococcus aureus, Streptococcus mutans*	[30]
		Whole plant	Carbohydrates, alkaloids, proteins, glycosides, phenols, tannins, flavonoids, saponins and steroids	Crude sample (400µg/disc) Zone of inhibition Gram-positive bacteria: *Staphylococcus aureus*- 10 mm, *Bacillus cereus*- 14 mm, *Bacillus subtilis*- 16 mm Gram-negative bacteria : *E. coli*- 19 mm, *Salmonella typhi*- 12 mm, *Pseudomonas aeruginosa*- 14 mm Fungi : *Candida albicans*- 2.5 cm, *Aspergillus niger*- 2 cm, *Microsporum canis*- 1.5 cm	[31]
4	*Bambusa vulgaris*	Leaves	Carbohydrates, tannins, phenols, saponins, flavonoids, volatile oils, steroids and proteins	Zone of inhibition in mm Methanolic extracts- 100mg/ml *S.aureus*- 15 mm, *B.subtilis*- 20 mm, *E.coli*- 21 mm, *K.pneumoniae*- 19 mm, *C.albicans*- 24 mm	[32]
		Leaves	Phenolic compounds, flavonoids, terpenoids, alkaloids, tannins, Alkaloids	Minimum inhibitory concentration [MIC]- mg/mL fungi : *Aspergillus niger* n-hexane- 1.25 ± 0.80, chloroform- 2.5 ±0.71, ethyl acetate extracts- 2.5 ± 0.71; *Verticillium albo-atrum* n-hexane- 5.0 ± 0.71, chloroform- 2.5 ± 0.71, ethyl acetate extracts- 1.25 ± 0.55; Gram-positive bacteria: *Bacillus cereus* n-hexane- 1.25 ± 0.23, chloroform- 2.5 ± 0.55, ethyl acetate extracts- 5.0 ± 0.10; *Staphylococcus aureus* n-hexane- 2.5	[15]

				± 0.77, chloroform- 5.0 ± 0.10, ethyl acetate extracts- 1.25; Gram-negative: *Escherichia coli* n-hexane- 2.5 ± 0.71, chloroform- 3.5 ± 0.23 ethyl acetate extracts- 1.25 ± 0.23; *Klebsiella pneumonia* n-hexane- 3.5 ± 0.23, chloroform- 2.5 ± 0.10, ethyl acetate extracts- 1.25 ± 0.55	

Conclusion

Diabetes and microbial infections are one of the leading causes of high economic loss which can in turn obstruct the progress of countries. Diabetes is a metabolic alteration, also many chronic complications such as blindness, heart failure, and renal failure caused by uncontrolled diabetes. In order to inhibit both diabetes and microbial infection, the expansion of research into new hypoglycaemic, potentially antidiabetic and antimicrobial agents is of great interest. Streptozotocin and alloxan induced diabetic mouse or rat was the most commonly used diabetic models. The methods used for the evaluation of antimicrobial activity are diverse but the most common one is disc diffusion method in which the zone of inhibition and minimum inhibitory concentration values are noted for the demonstration of antimicrobial efficacy.

This review has presented a list of anti-diabetic and antimicrobial medicinal grasses of the Poaceae family used in the treatment of diabetes mellitus and microbial infection. These medicinal grasses have bioactive phyto-constituents which showed hypoglycaemic, antihyperglycaemic, hypolipidemic and antimicrobial effects. Further researches are needed to establish the mechanism of action and isolation of phyto-constituents composition responsible for the concerned activity.

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